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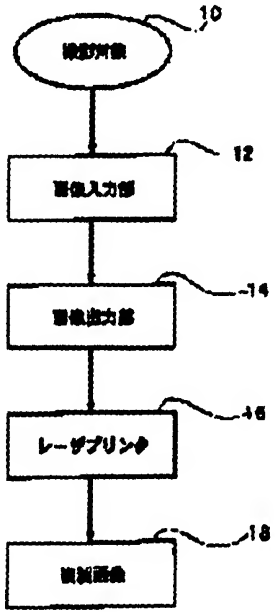
(54) OUTPUT METHOD FOR MULTI-BAND IMAGE AND DEVICE THEREFOR

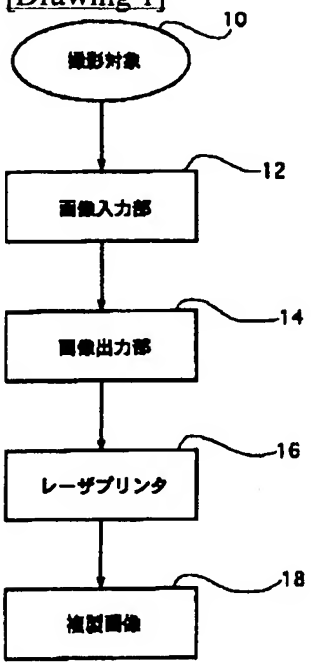
(57)Abstract:

PROBLEM TO BE SOLVED: To output an image that is most suitable to an object by converting the spectral waveform of every pixel of an image which is photographed by a multi-band camera into the control signals corresponding to plural image reproduction methods for outputting these spectral waveforms to an image output device and synthesizing those control signals to obtain a final control signal.

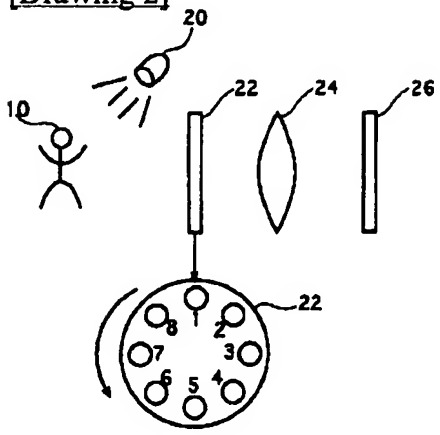


SOLUTION: A photographing object 10 is fetched from an image input part 12 as the multi-band image data, and a spectral waveform of the object 10 is estimated and converted into a control signal to output an image accordant with an object via an image output part 14. Then a duplicated image 18 is outputted from a laser printer 16 by the control signal. The reproduction of chromaticity is suitable when the coincidence of how to see is required between an original image and its duplicated image under a limited observation condition. Meanwhile, the reproduction of a waveform is suitable when the seeming stability is required under plural observation conditions where the seeming way is not changed so much despite the change of the observation condition. Thus, the different images are outputted according to the purpose for giving the priority to the coincidence of how to see or the stability of the how to see.

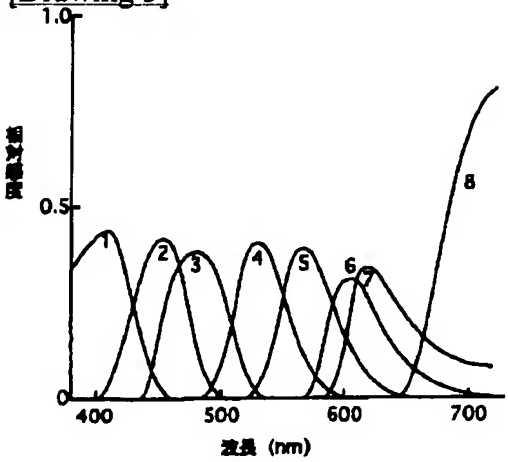
[Drawing 1]



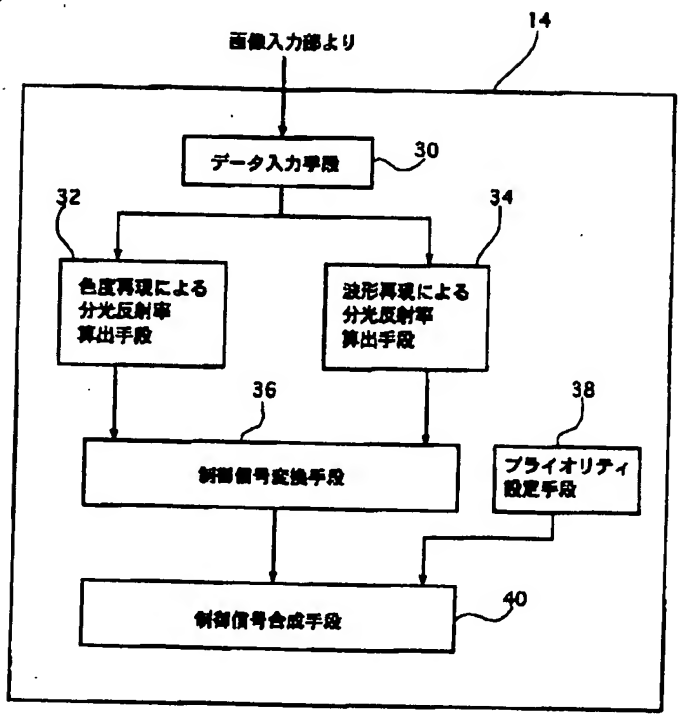
[Drawing 2]



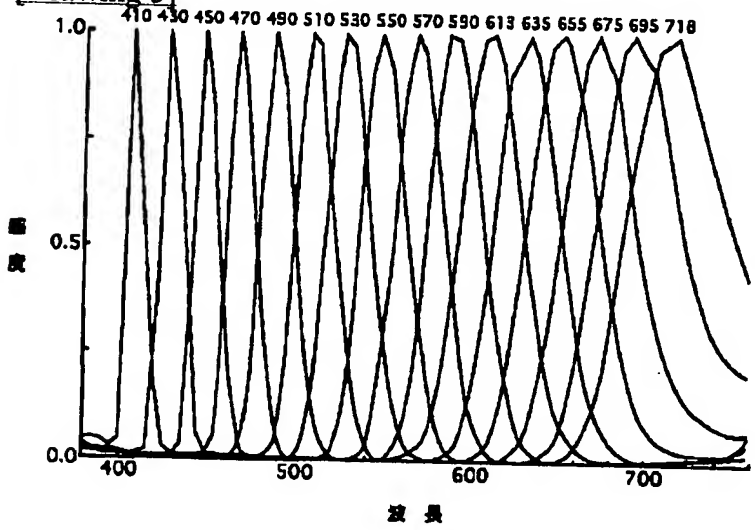
[Drawing 3]



[Drawing 4]


14
画像入力部より
データ入力手段
30
32
34
色度再現による
分光反射率
算出手段
波形再現による
分光反射率
算出手段
36
38
制御信号変換手段
プライオリティ
設定手段
制御信号合成手段
40

[Drawing 5]


410 430 450 470 490 510 530 550 570 590 613 635 655 675 695 718
1.0
0.5
0.0
400
500
600
700
強度
波長

[Problem(s) to be Solved by the Invention] However, there are the following problems in the above-mentioned chromaticity reappearing method and the wave reappearing method. That is, the chromaticity reappearing method has the problem that whenever [vanity's coincidence] deteriorates greatly, when observation conditions, such as the observation light source, change although it gives whenever [high vanity's between original and duplicate image coincidence] in performing color reproduction under the limited light source. Moreover, although the wave reappearing method gives whenever [stable vanity's which does not depend on observation conditions, such as the observation light source's, coincidence], whenever [under limited observation conditions / coincidence] has the problem of being inferior to the chromaticity reappearing method.

[0008] In case this invention is made in view of said conventional problem and outputs multi-band image data , it makes it a technical problem to switch the image reappearance approach continuously and to offer the multi-band image output method and the equipment which can output an image by the image reappearance approach which suited most the purpose whether to give priority to and carry out color reproduction of which of whenever [vanity of subject copy image and duplicate image coincidence] , and the stability of vanity .

[0009]

[Means for Solving the Problem] In order to solve said technical problem, the first mode of this invention is the output method of multi-band image data, it changes the part light wave form for every pixel of the image photoed by the multi-band camera into the control signal corresponding to two or more image reappearing methods for outputting to an image output machine, compounds said two or more control signals, and offers the multi-band image output method characterized by acquiring a final control signal.

[0010] Moreover, it is desirable that said two or more image reappearing methods include the chromaticity reappearance and wave reappearance of a spectrum wave for said every pixel.

[0011] Moreover, it is desirable to set up the priority to said two or more image reappearing methods, and to compound said two or more control signals based on said priority.

[0012] Furthermore, it is desirable that said priority is set up interactively.

[0013] In order to solve said technical problem, moreover, the second mode of this invention A data input means to input the multi-band image data obtained from the image photoed by the multi-band camera, A control signal conversion means to change the part light wave form for every pixel into the control signal corresponding to two or more image reappearing methods for outputting to an image output machine, Said two or more control signals changed by said control signal conversion means are compounded, and the multi-band image output unit characterized by having a control signal composition means to acquire a final control signal is offered.

[0014] Moreover, it is desirable to have a means to set up the priority to said two or more image reappearing methods, and for said control signal composition means to compound said two or more control signals changed by said control signal conversion means based on said priority, and to acquire a final control signal.

[0015]

[Embodiment of the Invention] Hereafter, the multi-band image output method concerning this invention is explained to a detail based on the suitable operation gestalt shown in an attached drawing.

[0016] Drawing 1 is the block diagram showing the outline of the image reappearance system incorporating the multi-band image output unit of this invention. it is shown in drawing 1 -- as -- this system -- the candidate 10 for photography (photographic subject) -- the image input section 12 -- as multi-band image data -- incorporating -- the spectrum for [10] photography -- a wave is presumed, and it changes into the control signal for outputting the image corresponding this to the purpose in the image output section (image output unit) 14, and outputs as a duplicate image 18 from a laser beam printer 16 with this control signal.

[0017] Chromaticity reappearance is suitable when whenever [vanity's of subject-copy image and duplicate image's under limited observation conditions coincidence] is called for. Wave reappearance is suitable when the stability of the vanity under two or more observation conditions which say that how for it to be visible on the other hand even if observation conditions change does not change a lot is searched for. It is made for this operation gestalt to output the image which switched the image reappearance approach and suited the purpose according to the purpose of image reappearance to any to give priority between whenever [vanity's coincidence], and the stability of vanity.

[0018] In this operation gestalt, the image input section 12 changes into digital image data two or more

images photoed by the multi-band photographic method by the multi-band camera, and sends them to the image output section 14. In this system, the spectral reflectance of the 10 for photography whole surface is measured using a multi-band image.

[0019] As shown in drawing 2 , the case where studio photography of the person is carried out is taken for an example, and the principle of a multi-band photographic method is explained. As shown in drawing 2 , the predetermined light source 20 is hit to the candidate 10 for photography (photographic subject), and it lets two or more channels from which spectral sensitivity differs pass using eight filters 22 with a transmitted wave length band which is different in the color information for [10] photography, and with a lens 24, image formation is carried out on monochrome film 26 which had almost uniform spectral sensitivity in the visible wavelength region, and eight photographs are taken. This image of eight sheets is read with an input device (for example, scanner), it changes into digital data, and the spectral reflectance for [10] photography is restored from that information. The relative sensibility obtained for every channel by drawing 3 is shown. From these data, the spectral reflectance f0 (lambda) for [10] photography can be presumed by using interpolation technique.

[0020] Moreover, for example, it has the CCD sensor which reads in photoelectricity the lens for photography, and the image of light which carried out image formation, the band pass filter which consist of at least four color filters in front of the above-mentioned lens for photography is arranged, and the approach of photoing the same photographic subject with sequential exchange is also mentioned in this band pass filter at the time of photography. Moreover, the technique which does not use the above-mentioned band pass filter with at least four sorts of CCD sensors which can read in photoelectricity the image which carried out image formation in at least four sorts of wavelength regions where the spectral sensitivity characteristic differs from the lens for photography can also be mentioned, and the band pass filter may be built into the CCD sensor in this case. Moreover, a liquid crystal tunable filter is sufficient as a band pass filter.

[0021] At this time, as there are many channels, it is highly precise, and although the spectral reflectance for photography can be restored, considering the simplicity of equipment, and compaction of exposure time, it is better [about 6-20 channels]. According to the simulation in a computer, since the degree of the improvement by increase of the number of channels is saturated with about eight channels, it comes out enough by about eight channels, and a certain thing is understood.

[0022] The multi-band image data the part light wave form for every pixel was presumed to be is changed into the control signal for outputting the image according to the purpose by the image output section 14. The outline configuration of the image output section 14 is shown in drawing 4 . As shown in drawing 4 , the image output section 14 from the data input means 30 and these data which receive the part light wave form for every pixel presumed from the image input section 12 A wave from which whenever [vanity's coincidence] is obtained A control signal conversion means 36 to change the spectral-reflectance calculation means 32 by the chromaticity reappearance for which it asks, the spectral-reflectance calculation means 34 by the wave reappearance which searches for a wave from which the stability of vanity is acquired, and each [these] wave into the control signal for outputting an image, respectively, Each control signal acquired in a priority setting means 38 to specify the priority to which to give priority between chromaticity reappearance and wave reappearance according to the purpose, and the top is compounded according to a priority, and a control signal composition means 40 to create one control signal for an image output is included.

[0023] The spectral-reflectance calculation means 32 by chromaticity reappearance computes the spectral reflectance f of the print with which whenever [vanity's coincidence] is obtained (lambda) from the spectral reflectance f0 for [10] photography (lambda). This is called for as a wave f (lambda) which makes said formula (3) min. On the other hand, the spectral-reflectance calculation means 34 by wave reappearance computes the spectral reflectance f of the print with which the stability of vanity is acquired (lambda) from the spectral reflectance f0 for [10] photography (lambda). This is called for as a wave f (lambda) which makes said formula (4) min. But in wave reappearance, a formula (5) or a formula (6) may be used instead of a formula (4).

[0024] Next, with the control signal conversion means 36, each spectral reflectance f (lambda) for which it asked in the top is changed into a control signal, respectively by the look-up table (LUT) showing the control signal at the time of a laser beam printer 16 hitting the laser beam of R, G, and B to printing paper, and carrying out image exposure (R, G, B), and relation with a spectral reflectance f (lambda). This LUT may be beforehand given to a system and may be created by the system. the patch of plurality when creating

from a laser beam printer 16 -- outputting -- it -- a spectrum -- what is necessary is to read by a colorimeter etc. and just to ask for the relation between the control signal at the time of a laser beam printer 16 outputting a patch, and the measured spectral reflectance The control signal which changed the spectral reflectance obtained by chromaticity reappearance is set to (R0, G0, and B0), and the control signal which changed the spectral reflectance obtained by wave reappearance is set to (R1, G1, and B1).

[0025] Moreover, the priority k which shows to which the case where coincidence of vanity is thought as important, and the stability of vanity may be needed by the application of an image etc., and priority is given more by it according to each purpose is set up with the priority setting means 38. And with the control signal composition means 40, two control signals (R0, G0, and B0) acquired in the top, and (R1, G1 and B1) are compounded using Priority k, and one control signal for an image output (Rk, Gk, and Bk) is acquired. This composition is performed by the following formula (7).

(Rk, Gk, and Bk) t =(1-k) -(R0, G0, and B0) t + k-(R1, G1, and B1) t ... (7)

Here, t of the right shoulder of a control signal expresses transposition (transpose).

[0026] When a final control signal is given by the above-mentioned formula (7), although Priority k can take the real number value of arbitration, the desirable range is 0<=k<=1. Thus, when asking for whenever [vanity's coincidence] by introducing Priority k, 0, then chromaticity reappearance (R0, G0, and B0) are obtained in k, and when searching for the stability of vanity, 1, then wave reappearance (R1, G1, and B1) are obtained in k, and in-between reappearance is also attained by putting other values into k. When this is summarized, it is expressed as shown in the next table 1.

(表1)

目的	見えの一致度	・・・	見えの安定性
再現方法 制御信号	色度再現 (R_0 , G_0 , B_0)	・・・ ・・・	波形再現 (R_1 , G_1 , B_1)

In this table, the part of ... expresses in-between reappearance. In this way, the image with which color reproduction which suited the purpose was performed is outputted from a laser beam printer 16. Although various image processings as occasion demands are performed at this time, explanation is omitted about it.

[0027] In addition, the priority setting means 38 is the keyboard connected to the personal computer which constitutes the image output unit which makes the principal part of this system in fact, and an operator drives in Priority k after this. And it is desirable to advance processing interactively so that the image for which carries out to reset up Priority k etc. while the output image after conversion is displayed on the display of a personal computer etc. and an operator looks at it, and it asks may be obtained.

[0028] in addition -- for an output machine (printer) -- the difference with chromaticity reappearance and wave reappearance -- the spectrum for photography -- the spectrum of wave f0 (lambda) and a print -- it is only the difference (difference in whether a formula (4) is used in the upper case, using a formula (3) (chromaticity reappearance) (wave reappearance)) of a definition of distance ||f0-f|| showing the nearness of Wave f (lambda). It follows, for example, the definition of said formula (5), a formula (6), or other distance other than a formula (3) and a formula (4) is used, only the number of distance with which these plurality was given searches for a control signal (Ri, Gi, and Bi), and it is Priority ki for every control signal. It gives, and like the following formula (8), these control signals can be compounded and an output machine can also be supplied.

(R, G, B) t =sigmaki and (Ri, Gi, and Bi) t/sigmaki ... (8)

Here, only several i (i= 0, ..., n) of the distance from which sigma differs is added. Therefore, even if the purpose is the same, as long as the definitions of distance differ, only the number of the distance given as mentioned above searches for a control signal, is compounded by the formula (8), and you may make it output it. When a final control signal is given by the above-mentioned formula (8), although each priority ki can take the real number value of arbitration, the desirable range is the non-negative real number. Thus, according to this operation gestalt, according to the purpose, the reappearance approach can be switched continuously.

[0029] Hereafter, a concrete example is explained.

(Example 1) In this example, studio photography of the person is carried out with a multi-band camera, and the spectral reflectance for every pixel is presumed by interpolation technique from the obtained image data of two or more channels. Especially this interpolation technique is good by the interpolation approach which is not limited and was usually learned well. Next, 9x9x9 kinds of print patches are outputted and created by the printer Pictrography3000 by Fuji Photo Film Co., Ltd. And the spectral reflectance of this print patch is measured with the Hitachi color analyzer C2000. The look-up table LUT showing the relation between a control signal and a spectral reflectance in coincidence with reference to the control signal at the time of outputting said print patch and the spectral reflectance of said print patch is created.

[0030] It asks for the spectral reflectance f (lambda) which makes said formula (3) min from the spectral reflectance for said every pixel, and this is changed into a control signal (R0, and G0 and B0) (the first control signal) using said LUT. Moreover, it asks for the spectral reflectance f (lambda) which makes said formula (4) min, and changes into a control signal (the second control signal) (R1, G1, and B1) using said LUT similarly.

[0031] And Priority k (0<=k<=1) is set up, said first control signal and second control signal are compounded by said formula (7), and it outputs as output image data. If Priority k is observed only under the fixed criteria light source with an output image, here In being what whenever [vanity's coincidence] is obtained by the first control signal by 0, then the chromaticity reappearance using a formula (3), and is observed under various observation light sources, Priority k The stability of vanity is acquired in Priority k by said second control signal by 1, then the wave reappearance using said formula (4). Moreover, the middle value, then the middle color reproduction of 0 and 1 are obtained in Priority k. For example, somewhat, although the stability of vanity is required, even if it drops stability, when saying that he wants also whenever [vanity's coincidence], it can switch the reappearance approaches, such as setting Priority k to 0.8, easily.

[0032] (Example 2) In this example, the multi-band camera manufactured with the following configurations is used. That is, the multi-band camera of this example consists of the CCD camera section, the part optical filter section, and a personal computer. a CCD camera -- CA-D 4-1024 made from DALSA -- A and PCI I/F was used. This CCD camera is monochrome and is 1024x1024 (pixel) pixel and the pixel size 12x12 (mu). A part optical filter is a liquid crystal tunable filter made from CRI, and Varispec TunableFilter RS232C. I/F was used. the wavelength range of 400-720nm, this comes out, is selectable to arbitration in main wavelength, and is the wavelength half-value width of 30nm, and 6 - 60% (it is dependent on wavelength) of permeability. Moreover, a personal computer is book mold PC(Windows 95) C++ made from PROSIDE, CPU is 166MHz and RAM is 128 M bytes.

[0033] The Macbeth chart and the person face were photoed as a photographic subject on the following photography conditions using the above multi-band cameras. Photography conditions are photographic subject illuminance 12000lux as the light source. Using the metal halide lamp, a lens is Nikomart (f= 50mm, F1.4), and F2.8 was used for it. Moreover, using ultraviolet and an infrared cut-off filter, the wavelength band (410nm or less and 730nm or more) was cut, and the spectrum image of 16 sheets was obtained as data (digital data) about the wavelength (channel) of 16 which divided the wavelength range of 410nm - 710nm at intervals of [of 20nm] wavelength as shown in drawing 5 . in addition, exposure time -- the exposure time of one shot -- 25msec(s) -- it is -- total exposure time -- 3sec(s) it is .

[0034] Thus, six steps are chosen from the gray charts of the Macbeth chart in the input image of each obtained wavelength of 16 sheets, and the digital data value is sampled. This digital data value and the spectral reflectance of six steps of already obtained Macbeth chart gray are contrasted, and a 1-dimensional look-up table (1DLUT) is created. And all the digital data values of an input image are changed into a spectral reflectance using 1DLUT for every wavelength of this. And the spectral reflectance for every pixel is obtained.

[0035] Below, like said example 1, to the spectral reflectance for every pixel, it asks for the spectral reflectance which makes said formula (3) min, and this is changed into a control signal (first) using LUT of said example 1. Moreover, on the other hand, it asks for the spectral reflectance which makes said formula (4) min, and this is similarly changed into a control signal (the second) using said LUT. And Priority k (0<=k<=1) is set up, said first control signal and second control signal are compounded by the formula (7), and it outputs as output image data.

[0036] As explained above, according to this operation gestalt, according to the purpose of image reappearance, it becomes possible to switch the image reappearance approach continuously. Consequently,

an image can be outputted by the image reappearance approach which suited most the purpose whether to give priority to and carry out color reproduction of which of whenever [vanity's of subject-copy image and duplicate image coincidence], and the stability of vanity.

[0037] As mentioned above, although the image output method and equipment of a multi-band image of this invention were explained to the detail, as for this invention, in the range which is not limited to what was explained above and does not deviate from the summary of this invention, it is needless to say that various amelioration and modification may be made.

[0038]

[Effect of the Invention] According to this invention, according to the purpose of image reappearance, the image reappearance approach could be switched continuously and it became possible to output an image by the image reappearance approach which suited most the purpose whether to give priority to and carry out color reproduction of which of whenever [vanity's of subject-copy image and duplicate image coincidence], and the stability of vanity as explained above.

[Translation done.]